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October 18, 2000

Mr. George Robin
Groundwater Office of the Environmental Protection Agency Region IX
75 Hawthorne Street
San Francisco, California 94105

Dear Mr. Robin:

SUBJECT: Underground Injection Control (UIC) Permit Application No. CA200002
Responses to CURE comments on draft UIC permit for Elk Hills Power Plant

Comments by CURE on the draft UIC permit for the Elk Hills Power Plant were submitted in letters of August 21 and 23, 2000, by Ms. Katherine Poole; a letter of August 21, 2000, by Ms. Phyllis Fox; and a letter of August 18, 2000, by William Lettis & Associates (WLA). Most of CURE's comments on waste front calculations, USDW issues, injectate analysis, suspected faults, nature of the confining zone, and well construction were previously raised and resolved[1]. This letter responds only to issues that have not already been addressed.

Underground Sources of Drinking Water (USDWs)

An aquifer is defined as geological formation, group of formations, or part of a formation that is capable of yielding a significant amount of water to a well or springs (40 CFR 146.3). The Elk Hills area is located in a hot, arid environment. Precipitation averages about six inches per year, whereas the average evaporation rate is about 62 inches per year[2]. Evaporation exceeds precipitation every month of the year. While ephemeral stream channels may contribute to some groundwater recharge, they cannot reasonably be expected to support fresh alluvial aquifers in the Elk Hills area or be considered as an USDW.

Ms. Fox is incorrect in stating that the Tulare Formation is not exempt as a USDW outside of the boundaries of the Elk Hills field. According to Mr. Randy Adams of the Division of Oil, Gas, and Geothermal Resources (DOGGR), the Tulare Formation is an exempted aquifer in the Buena Vista Front area of the Buena Vista oil field, which directly adjoins the Elk Hills oil field to the south (personal communication with Mr. Barry Hanson, 9/27/00). However, the 2,500-ft distance from the Elk Hills oilfield boundary is the main reason that injectate will not migrate past this boundary.

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[1] SJEC letter of 3-7-00 to EPA; SJEC letter of 3-27-00 to EPA; SJEC e-mail of 5-16-00 to EPA; SJEC e-mail of 5-27-00 to EPA; and SJEC e-mail of 6-7-00 to EPA.

[2] Elk Hills Power Project Application for Construction, p.5.4-1.

Numerous calculations using a variety of waste plume geometries and formation characteristics have been done, demonstrating that even under significantly less favorable conditions, the waste front is not likely to migrate off-site[3].

Attachment 1 of the Underground Injection Control Permit Application, dated September 21, 1999, shows that extensive drilling already has been done in the area of the proposed injection wells. Ms. Fox's idea to drill seven additional wells in this area is not reasonable given the amount of subsurface data already available.

Injectate Analysis

CURE claims that injectate arsenic levels would be concentrated to about 29 mg/l, which would violate *proposed* drinking water standards. Ms. Fox is citing a proposed regulation, not an existing and applicable one. CURE's submittal also demonstrates that even native Tulare groundwater fails to conform to the proposed arsenic standards.

Monitoring Plan

A monitoring plan with quarterly sampling and reporting will be provided.

Corrective Action Plan

Abandoned well 2-18G is being reviewed. Corrective action will be proposed as necessary.

Fluid Compatibility

It is in the best interest of Elk Hills Power to prevent formation damage caused by fluid incompatibility. The types of potential problems discussed by Ms. Fox can be successfully mitigated using various pre-injection filtration and chemical treatment methods. Any fluid compatibility analyses will be much more accurate if actual injectate samples are analyzed.

Area Of Review

Ms. Fox contends that the 0.5-mile area of review used for the Elk Hills Power Plant is too low for a Class I well. Using the Platt reference of 3/17/98, she cites that Minnesota[4], Illinois, Louisiana, New Mexico, Texas, and Kansas use fixed radii of 1 to 2.5 miles. She does not appear to

[3] SJEC letter of 3-7-00.

[4] This should be Michigan.

recognize the basic differences in the geologic characteristics between these areas and California. The regions cited by Ms. Fox as using larger radii have much poorer permeability and porosity in injection zones than California, which means that they hold much less fluid per unit volume than the Tulare Formation.

The examples in the Platt reference cited by Ms. Fox also are incomplete and misleading. She does not distinguish between whether the fixed radii are for Class I hazardous wells and Class I non-hazardous wells. For example, New Mexico actually has a 0.25-mile fixed radius for Class I non-hazardous wells rather than the 2.5-mile radius stated by Ms. Fox. She also omits that Arkansas has a fixed radius of 0.5 miles for Class 1 non-hazardous wells and Ohio has a 0.25-mile radius for Class I wells. Given the high permeability and porosity of the receiving formation, the 0.5-mile area of review is entirely appropriate for this project and is the same area of review used for similar competing California projects, including La Paloma and numerous other permitted Class I non-hazardous injection wells.

In determining the area of review, 40 CFR 146.6(a)(2) does not specifically require that a modified Theis equation be used. It states that computation of the zone of endangering influence *may* be based on the modified Theis equation, which is "…*one* form which the mathematical model *may* take [italics added]." The Warner & Lehr equation used in the permit application certainly qualifies as a comparable method and is a standard industry-accepted method of calculating a radius of influence. The Warner & Lehr method also has been used and accepted for several competing projects, including La Paloma and other permitted Class I non-hazardous injection wells. Furthermore, pressure front calculations were provided in Attachment 18 of the Underground Injection Control permit application to evaluate potential pressure build-up caused by injection operations.

The assertion by Ms. Fox that SJEC only estimated the minimum radius of influence is incorrect. First, sensitivity calculations were submitted to the Environmental Protection Agency (EPA) showing waste front estimates for a variety of parameters. Second, SJEC assumed a continuous injection of 15,000 BWPD throughout the project's life, which is 25% greater than the daily average disposal requirement, and built other assumptions and value ranges into the calculations to ensure they remained conservative[5]. Finally, the 0.5-mile area of review used by SJEC was almost five times greater than the area of influence calculated for 30 years using the Warner & Lehr equation.

Ms. Fox's calculations suggesting that the waste radius from the proposed injectors may migrate into a non-exempt USDW also is incorrect. She uses an equation that actually calculates the maximum radius of *pressure* influence rather than the waste front radius. The "influence radius" calculated by Ms. Fox represents how far out into the reservoir a pressure change caused by injection pressure (or drawdown) could be detected. Since water is essentially incompressible, only pore friction pressure and rock compressibility dampen the injection pressure propagation. Thus, the pressure radius can be large and has nothing to do with the waste front radius of the disposal wells. Given the formation parameters previously cited ($\varnothing$ = 0.34; h = 750 ft) and Ms.

[5] SJEC letter of 3-7-00 to EPA.

Fox's radius of 4980 ft, the pore volume in a cylinder of rock of these dimensions is about 5.84 X 10^{10} ft^3. At the maximum project injection rate of 84,218 ft^3/day, Elk Hills Power would have to inject for 693,849 days, or 1,900 years, to fill such a volume.

Ms. Fox contends that the area of review may be determined by establishing a fixed radius *only* for wells permitted under 40 CFR 122.38. However, this is inconsistent with her referencing the Platt document of 3/17/98, which summarizes the various fixed radii used by states for different types of injection wells. Fixed radii to determine areas of review clearly are in use by the EPA for all classes of UIC wells.

CURE's complaint that area of influence calculation was only for 20 years has already been addressed. Equations for 30 years, as well as for varied waste plume geometries and formation characteristics[6], have been submitted. This issue also was addressed during cross-examination of Barry Hanson by the CURE attorney during the CEC hearings on March 9, 2000.

Ms. Fox is incorrect in her assertion that sandstones typically have a porosity of 1% to 5%. The typical porosity range in California actually is 15% to 40%. Analysis of core and log data from the Tulare Formation by SJEC and numerous other objective parties, such as DOGGR, Bechtel Petroleum, U.S. Department of Energy, Chevron USA, validates a 34% porosity in the waste front calculations. In addition, sensitivity analyses using lower porosities were run and have been submitted to the EPA[7].

Finally, Ms. Fox errs in asserting that a higher dispersion coefficient should have been used in waste front calculations. The dispersion coefficient used by Ms. Fox was 65 ft rather than the 3 ft used by SJEC. Warner & Lehr state that a 65 ft dispersion coefficient is used for limestone or dolomite aquifers and a 3 ft coefficient for sandstone aquifers[8]. The lithology of the Tulare injection zone consists primarily of sands and gravels. Ms. Fox applies an incorrect dispersion coefficient either because she misidentified lithology of the injection zone or underestimated the porosity of California sandstones.

Please call if you have any questions or would like to discuss this matter further.

Sincerely,

[6, 7] SJEC letter of 3-7-00 to EPA.

[8] Warner, D. L., & Lehr, J. H., 1981. *Subsurface Wastewater Injection. The Technology of Injecting Wastewater into Deep Wells for Disposal*: Premier Press, Berkeley, pp. 112-113.

Donna M. Thompson Barry Hanson

cc: Mr. Dennis Champion, Elk Hills Power, LLC
Mr. Terry Schroepfer, Quad Knopf